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A new observation on abnormal development in benthic foraminifers: *Peneroplis pertusus* (Forskål) - *Peneroplis planatus* (Fichtel and Moll) togetherness

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Resumen

Nueva observación de desarrollo anómalo en foraminíferos bentónicos: unión de Peneroplis pertusus *(Forskål)* - Peneroplis planatus *(Fichtel and Moll)*

Se ha investigado la agrupación de foraminíferos alrededor de un surgimiento submarino en la bahía de Ilica, (Çeşme, Esmirna). Se observó una fauna rica de foraminíferos, dominada por Peneróli-dos. Los individuos con morfología anormal fueron comunes en 8 géneros y 11 especies de Penerólidos. Se observó por primera vez la unión de *Peneroplis pertusus* (Forskål) y *Peneroplis planatus* (Fichtel and Moll).

Palabras clave: Peneróplidos, Mediterráneo, Bahía de Ilica, Turquía.

Abstract

Benthic foraminifer assemblages around a submarine spring in Ilıca Bay (Çeşme, Izmir) have been investigated. A rich foraminiferal fauna, dominated by Peneroplids were observed. Indviduals with abnormal test morphology was also common in 8 genera and 11 species of Peneroplids. *Peneroplis pertusus* (Forskål) and *Peneroplis planatus* (Fichtel and Moll) togetherness was observed for the first time.

Key words: Peneroplids, Mediterranean, Ilıca Bay, Turkey.

Introduction

Alterations and rapid changes in ecological parameters, such as salinity variations, temperature, solubility of calcium carbonate, dissolved oxygen, illumination, anthropogenic heavy metal pollution or heavy metals carried by groundwater are suggested to cause abnormal test development in foraminifers (Boltovskoy et al. 1991, Almogi-Labin et al. 1992, Yanko et al. 1998, Stouff et al., 1999a, 1999b, Geslin et al. 2000, 2002, Elberling et al. 2003). Abnormal test morphology have been reported from many locations worldwide (Cushman 1929, Cimerman and Langer 1991, Loeblich and Tappan 1994) and are known to be common in certain foraminifer genera and species (Geslin et al. 1998, Stouff et al. 1999a, 1999b).

Besides the morphological abnormalities, twins and triplets are common anomalies observed in benthic foraminifera. Conjoined twin, triplet and quadruplet individuals have been reported from Turkish coasts (Meriç 1996, Meriç et al. 2008a). The most striking abnormality was the conjoined twins formed by two different species, such as twins of *Peneroplis pertusus*-*Cosci-*

nospira hemprichii, *Peneroplis planatus-Coscinospira hemprichii* and *Vertebralina striata-Coscinospira hemprichii* (Sellier de Civrieux, 1970; Meriç et al. 2005, 2008a, 2008b, 2009a).

In the frame work of this study, foraminiferal assemblage around a submarine spring in Ilıca Bay (Çeşme, İzmir) was investigated. Besides a rich foraminiferal fauna, a twin of *Peneroplis pertusus-Peneroplis planatus* was observed for the first time.

Material and methods

The spring is located in Ilıca Bay, on the northwestern of Karaburun Peninsula, the coordinates are 0444185E and 4240949N. The spring was taken as the center and a total of 38 recent sediment samples were collected at different points on three lines, A (210º N), B (120 N) and C (290º N) directions. Sediment samples were collected at each 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90 and 100 m distances according to the spring. But, because of a jetty, samples beyond 40 m could not be obtained on line A (Fig. 1).

5 grams of wet sediment samples were weighed and treated with 10 % H_2O_2 for 24 hours. The samples were washed with pressurized water on 0.063 sieve and dried at 50 ºC oven. The dried samples were further sieved with 2.00, 1.00, 0.500, 0.250, 0.125 mm mesh sizes. The foraminifer individuals were separated under binocular microscope.

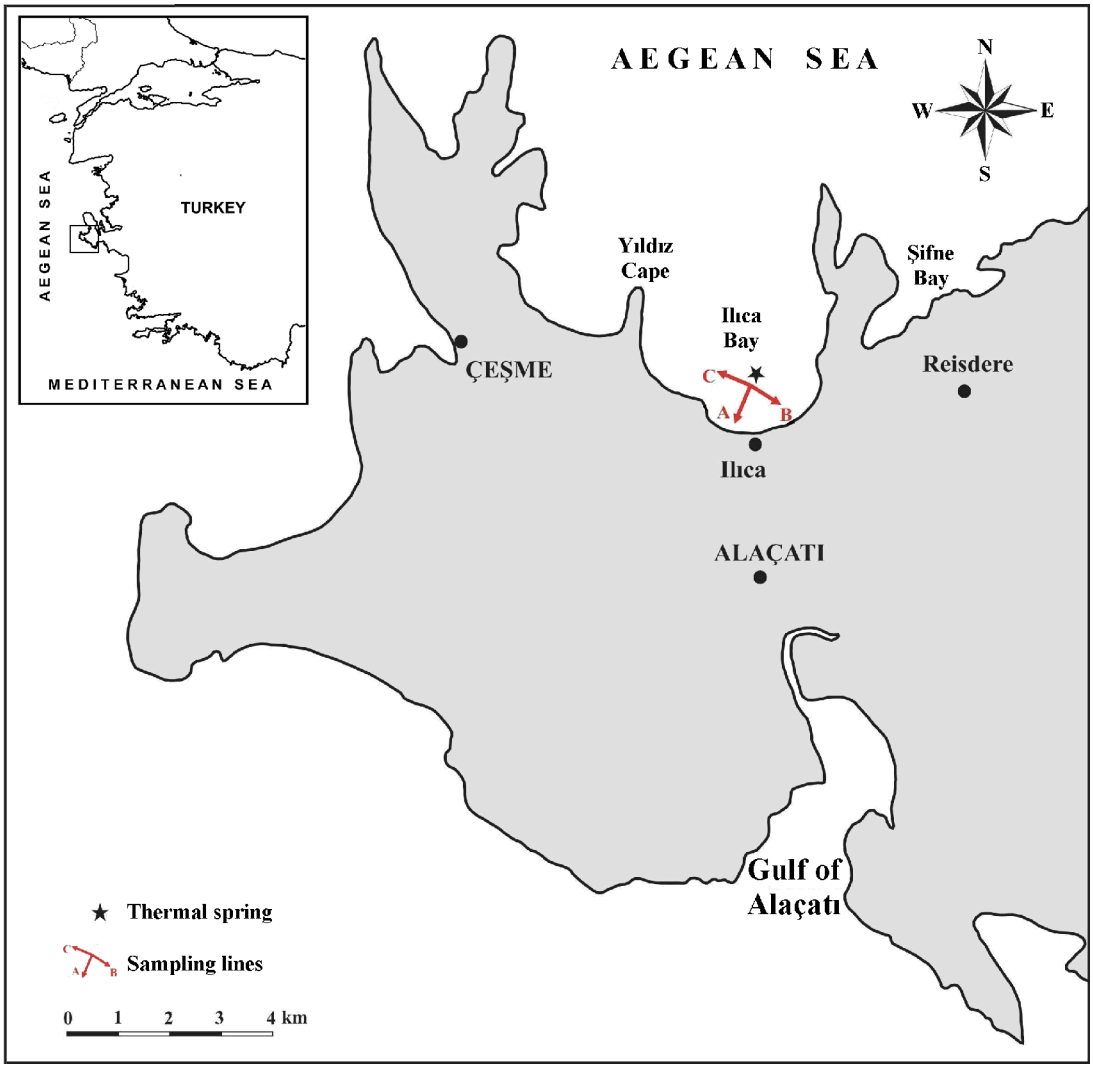

Figura 1. Área de estudio

Figure 1. Location of the study area.

Results

Foraminiferal assemblage

45 genera and 80 species of benthic foraminifer species were identified in 38 samples; *Textularia bocki* Höglund, *Spirillina vivipara* Ehrenberg, *Vertebralina striata* d'Orbigny, *Nodopthalmidium antillarum* (Cushman), *Nubecularia lucifuga* Defrance, *Adelosina carinata-striata* Wiesner, *A. cliarensis* (Heron-Allen and Earland), *A. mediterranensis* (Le Calvez J. and Y.), *Spiroloculina angulosa* Terquem, *S. antillarum* d'Orbigny, *S. ornata* d'Orbigny, *Siphonaperta agglutinans* (d'Orbigny), *S. aspera* (d'Orbigny), *Cycloforina contorta* (d'Orbigny), *C. villafranca* (Le Calvez J. and Y.), *Lachlanella variolata* (d'Orbigny), *Massilina gualteriana* (d'Orbigny), *M. secans* (d'Orbigny), *Quinqueloculina berthelotiana* d'Orbigny, *Q. bidentata* d'Orbigny, *Q. jugosa* Cushman, *Q. laevigata* d'Orbigny, *Q. lamarckiana* d'Orbigny, *Q. seminula* (Linne), *Miliolinella elongata* Kruit, *M. labiosa* (d'Orbigny), *M. subrotunda* (Montagu), *M. webbiana* (d'Orbigny), *Pseudotriloculina laevigata* (d'Orbigny), *P. oblonga* (Montagu), *P. rotunda* (d'Orbigny), *P. sidebottomi* (Martinotti), *Triloculina bermudezi* Acosta, *T. cf. fichteliana* d'Orbigny, *T. marioni* Schlumberger, *T. scheriberiana* d'Orbigny, *Sigmoilinita costata* (Schulmberger), *S. edwardsi* (Schlumberger), *Articulina carinata* Wiesner, *Parrina bradyi* (Millet), *Euthymonacha polita* (Chapman), *Coscinospira acicularis* (Batsch), *C. hemprichii* Ehrenberg, *Laevipeneroplis karreri* (Wiesner), *Peneroplis arietinus* (Batsch), *P. pertusus* (Forskål), *P. planatus* (Fichtel and Moll), *Amphisorus hemprichii* Ehrenberg, *Sorites orbiculus* Ehrenberg, *Polymorphina* sp.3, *Polymorphina* sp.5, *Polymorphina* sp.7, *Brizalina spathulata* (Williamson), *Reussella spinulosa* (Reuss), *Neoeponides bradyi* Le Calvez, *Gavelinopsis praegeri* (Heron-Allen and Earland), *Neoconorbina terquemi* (Rzehak), *Rosalina bradyi* Cushman, *R. globularis* d'Orbigny, *Pararosalina cf. dimorphiformis* McCulloch, *Planoglabratella opercularis* (d'Orbigny), *Cyclocibicides vermiculatus* (d'Orbigny), *Lobatula lobatula* (Walker and Jacob), *Planorbulina mediterranensis* d'Orbigny, *Cibicidella variabilis* (d'Orbigny), *Cymbaloporetta plana* (Cushman), *C. squammosa* (d'Orbigny), *Miniacina miniacea* (Pallas), *Asterigerinata mamilla* (Williamson), *Nonion depressulum* (Walker and Jacob), *Ammonia compacta* Hofker, *A. parkinsoniana* (d'Orbigny), *A. tepida* Cushman, *Challengerella bradyi* Billman, Hottinger and Oesterle, *Cribrodelphidium poeyanum* (d'Orbigny), *Porosononion subgranosum* (Egger), *Elphidium aculeatum* (d'Orbigny), *E. advenum* (Cushman), *E. complanatum* (d'Orbigny), *E. crispum* (Linne), *E. depressulum* (Cushman), *Elphidium* sp. (Meriç and Avşar 2001, Meriç et al. 2002a, 200b, 2003a, 2003b, 2004, 2008c, 2009b). Nine of these species were Indo-Pacific originated.

Abnormal foraminifers

Peneroplids were found to be dominant in the investigated assemblages. Accordingly, abnormal test morphology was observed in the genera and species of this group. The test abnormalities were observed in 8 genera and 11 species, *Vertebralina striata* d'Orbigny, *Spiroloculina angulosa* Terquem, *Coscinospira acicularis* (Batsch), *C. hemprichii* Ehrenberg, *Laevipeneroplis karreri* (Wiesner), *Peneroplis arietinus* (Batsch), *P. pertusus* (Forskål), *P. planatus* (Fichtel and Moll), *Sorites orbiculus* Ehrenberg, *Lobatula lobatula* (Walker and Jacob), *Cibicidella variabilis* (d'Orbigny). However, the most abundant two genera which showed test abnormality were *Coscinospira* and *Peneroplis*¸ and the five species were *Coscinospira acicularis* (Batsch), *C. hemprichii* Ehrenberg, *Peneroplis arietinus* (Batsch), *P. pertusus* (Forskål), *and P. planatus*. (Fichtel and Moll). The togetherness between *Peneroplis pertusus-Peneroplis planatus* was observed for the first time (Fig. 2).

Discussion

Morphological abnormalities of foraminifer tests are considered to be indicators of stressed environments, and some species are used as bioindicators for anthropogenic pollution. However, it has been shown that the environmental stress may also be exerted by natural factors such as, hypersalinity, periodical acidification and strong hydrodynamics. Short-term changes in the salinity of seawater could result in morphological anomalies in benthic foraminifer tests (Geslin et al. 2002, Nigam et al. 2006, Meriç et al. 2008d). Thus, high ratios of abnormal to normal tests can also be observed in environments protected from human impact.

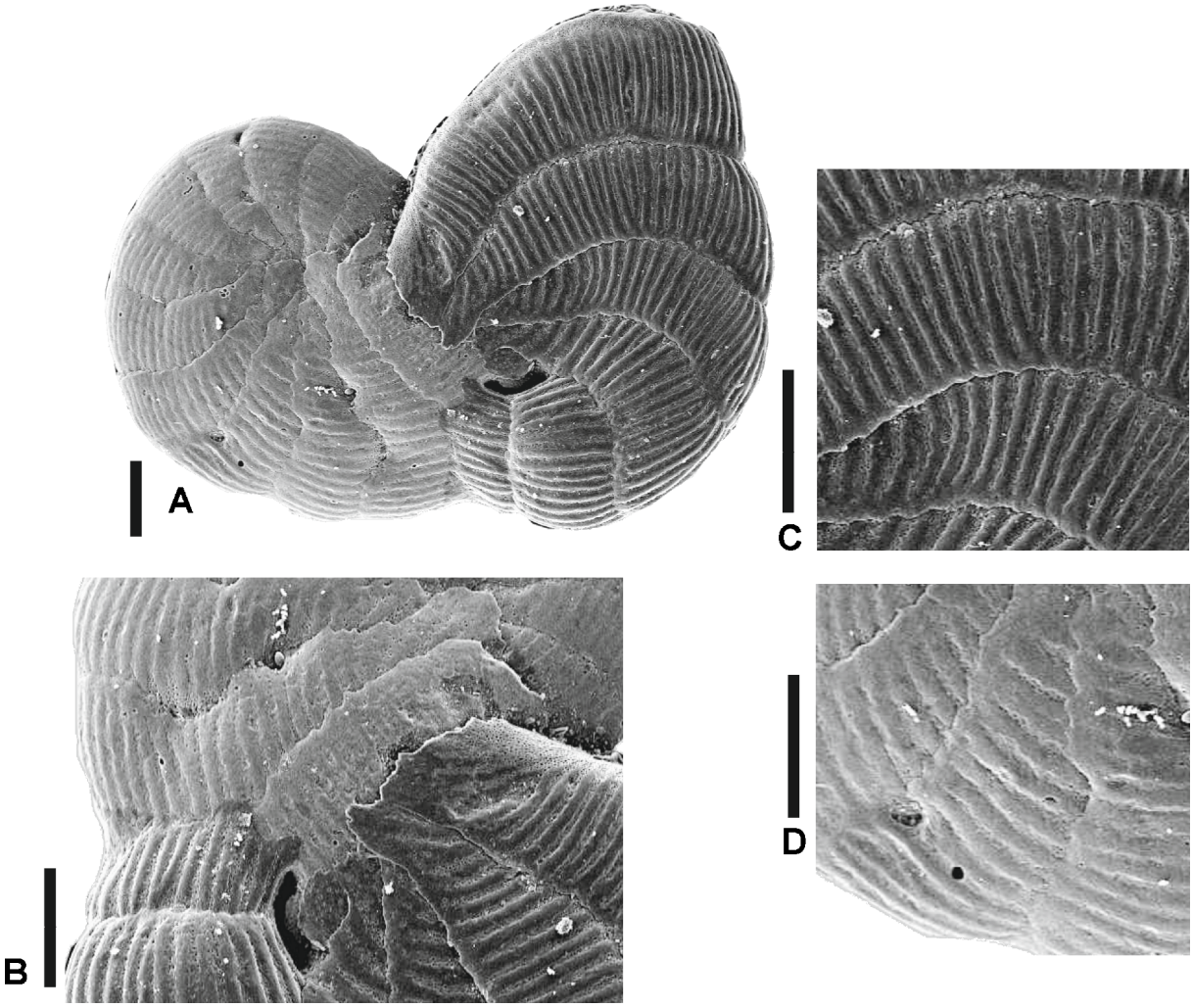

Figura 2. Unión de *Peneroplis pertusus* (Forskål) y *Peneroplis planatus* (Fichtel and Moll). **A.** Visión externa. **B**. Zona de unión de *Peneroplis planatus* (Fichtel and Moll) - *Peneroplis pertusus* (Forskål). **C**. Primer plano de *Peneroplis planatus* (Fichtel and Moll). **D**. Primer plano de *Peneroplis pertusus* (Forskål). C-90 m, Bahía de Ilica, Çeşme, Esmirna, Turquía. Barra de escala 100µm.

Figure 2. *Peneroplis pertusus* (Forskål) and *Peneroplis planatus* (Fichtel and Moll) togetherness. **A.** External view. **B**. *Peneroplis planatus* (Fichtel and Moll) - *Peneroplis pertusus* (Forskål) attachment site. **C**. *Peneroplis planatus* (Fichtel and Moll) close up view. **D**. *Peneroplis pertusus* (Forskål), close up view. C-90 m, Ilıca Bay, Çeşme, İzmir-Turkey. Scale bar 100µm.

In this study a rich foraminiferal assemblage, represented by 48 genera and 80 species were observed. Morphologically abnormal individuals were also abundantly observed, mainly in Peneroplids. Examples of abnormal togetherness in Peneroplidae between *Coscinospira hemprichii-Peneroplis pertusus*, *Coscinospira hemprichii-Peneroplis planatus* and *Vertebralina striata-Coscinospira hemprichii* have been previously reported (Meriç¸ et al., 2008b; Meriç et al., 2009a). However, the specimen from Ilıca Bay presents togetherness between *Peneroplis pertusus-Peneroplis planatus* (Fig. 2.)

Conclusion

The reproduction methods of the recent foraminifers, schizogony and gamogony, have been studied by many researchers (Le Calvez, 1950, 1953; Grassé, 1953; Berthold, 1971; Röttger and Spindler, 1976). Schizogony is asexual production of macrospheric individuals from microspheric ones which takes place in cold seasons. Alternatively, gamogony is the production of microspheric individuals from the fusion of the gametes of two parental individuals, which is observed in summer. Abnormal individuals with morphological characteristics of two separate species are very rare events, which may not only be formed by pollution but also by chance. In this case a juvenile of *Peneroplis planatus* might have been fused with *Peneroplis pertusus* juvenile, or the *Peneroplis planatus* juvenile might have been attached to the aperture of a dead *Peneroplis pertusus* indi-

vidual and have been grown on it. Laboratory experiments or genetic analysis may solve the mystery of abnormal togetherness among different species of foraminifera.

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